

Final

**Predation Management Plan for
Least Tern and Piping Plover
Habitat along the Missouri River**

**US Army Corps of Engineers
Missouri River Recovery
Integrated Science Program**

July 2009

Overview.....	3
Purpose.....	3
Predation Management Plan Objectives.....	5
Background and Description of Problem.....	6
Review of Previous Predation Management Efforts on the Missouri River.....	19
Management Plan.....	22
Management Tools.....	22
Habitat Enhancements.....	22
Exclusion Cages.....	23
Exclusion Fencing.....	24
Hazing.....	24
Avian Nest Manipulation.....	25
Conditioned Taste Aversion.....	25
Removal.....	26
Guidelines for Management Actions.....	26
Exclusion Cages.....	28
Exclusion Fencing.....	28
Hazing.....	28
Removal.....	29
Coyote.....	31
Mink.....	31
Raccoons.....	32
Great Horned Owls.....	32
Special Cases.....	33
Reach Specific Removal Actions.....	33
Nebraska/South Dakota Boundary Waters.....	33
South Dakota.....	35
North Dakota.....	35
Montana.....	35
Disposal of Captured Animals.....	36
Monitoring, Reporting and Evaluation.....	37
Cooperators.....	38
Alternatives to Consider.....	38
Proposed Plan.....	38
Non-lethal Removal Only.....	39
Indirect Management Only.....	39
No Additional Predation Management.....	40
Permits.....	40
References Cited.....	40

Overview

As the primary agency charged with managing threatened and endangered species populations and their habitats on the Missouri River, the U.S. Army Corps of Engineers Omaha District (Corps) has a responsibility to implement actions to prevent jeopardy of these species.

Pursuant to responsibilities under the Endangered Species Act (ESA) and in conjunction with other management activities, the Corps may implement, per available funding, management actions to reduce predation on threatened and endangered species that nest on the Missouri River. Species intended to benefit from this action include the federally endangered interior population of least tern (*Sternula antillarum*) and the federally threatened northern Great Plains population of piping plovers (*Charadrius melodus*).

This document offers an overview of the biological basis for predation management on the Missouri River to protect tern and plover populations. It presents the Corps' perspective on predation management, lays out the reasons for specific management actions, describes the scientific information assembled by the Corps that affects decisions on implementing predation management, and explains how the Corps will implement the plan and evaluate results. This document will be updated as new information and findings become available.

Purpose

The purpose of this Predation Management Plan is to describe actions the Corps may implement to manage predation of least terns and piping plovers on the Missouri River. Because predation impacts the productivity (reproductive success) and adult survival of the least tern and piping plover (USACE 2008), predation management is an important strategy to aid in the recovery and conservation of these listed species (USFWS 2003).

The implementation of this predation management plan is intended to increase the productivity of the Missouri River's federally listed threatened and endangered

shorebirds. Numerous incidents of predation for both species are documented annually by the Corps' Tern and Plover Monitoring Program (TPMP) as well as by other agencies and organizations conducting research on behalf of the Corps (USACE 2008). The Missouri River has been identified as important to breeding populations of the least tern and piping plover. However, decreases in habitat quality and quantity as well as changes in predator population dynamics may adversely affect tern and plover populations.

Predation management has been identified in the species recovery plans for the least tern and piping plover as well as the 2000 Biological Opinion and 2003 Biological Opinion Amendment for the Missouri River as a recovery and conservation action that must be considered if recovery of these species is to be achieved (USFWS 1988, 1990, 2000, 2003). The 2000 Biological Opinion and 2003 Biological Opinion Amendment list Reasonable and Prudent Measures (RPMs) to minimize take for the two species. Because the RPMs in the 2003 Biological Opinion Amendment supercede those found in the 2000 Biological Opinion, only the 2003 Biological Opinion Amendment will be referenced in the remainder of this plan. For piping plovers, RPM 6 states: "The Corps shall evaluate and implement actions to reduce predation on piping plover nests, chicks, and adults" (USFWS 2003). For least terns, RPM 5 states: "Predation has a major impact on the productivity of Missouri River least terns. Therefore, it is important to identify and implement the most effective methods to reduce predation levels and reduce the amount of predation that is influenced by Corps' activities" (USFWS 2003).

However, it is recognized that managing predation alone cannot achieve the recovery goals established for the least tern and piping plover, which is why this predation management plan is just one component of a larger overall management strategy for the Missouri River. Management actions are undertaken throughout the breeding season to protect least tern and piping plover nesting sites and to improve the productivity of the two species. Through its least tern and piping plover management strategy, the Corps:

- Increases the amount of available nesting habitat for least terns and piping plovers by constructing new sandbars or removing vegetation from existing sandbars

- Protects nests from rising river or reservoir levels by moving nests to a higher location or raising the nest at the existing location
- Relocates chicks on sandbars that may be inundated due to rising river levels to higher sandbars or constructs platforms to provide shelter for the chicks
- Protects nesting sites from human disturbance by placing restriction signs on sandbars and beaches warning the public of endangered species

These management actions for the least tern and piping plover are implemented under the Missouri River Recovery Program, which was initiated to restore some of the Missouri River ecosystem's natural form and function. Its mission is to implement actions to accomplish Missouri River ecosystem recovery goals in coordination and collaboration with agency partners and stakeholders.

Ongoing predation management efforts will focus on implementing a combination of management actions in a manner that will, at a minimum, sustain current populations of the least tern and piping plover and ideally improve productivity and increase the Missouri River populations of these species. In the future as population parameters improve and research and monitoring data become available we will refine management strategies to a more passive approach.

Predation Management Plan Objectives

- Increase the productivity of least terns and piping plovers by reducing the loss of eggs and chicks to predation and reducing the number of adults that are lost or driven away due to disturbance by predator species.
- Identify tools available to reduce predation on least tern and piping plover eggs, chicks and adults.
- Provide guidelines for the implementation of management actions.
- Provide a process for the evaluation of the effectiveness of predator management in achieving objectives and to make modifications to the plan as needed.

Background and Description of Problem

The Missouri River provides important breeding habitat for the least tern and piping plover. The majority of nesting on the Missouri River by both species occurs below Gavins Point and Garrison Dams. Least terns can also be found in small numbers below Fort Peck and Fort Randall Dams and occasionally limited nesting occurs on reservoir segments. Piping plovers also nest heavily on Lake Sakakawea and Lake Oahe with limited nesting occurring on Fort Peck Lake, Lewis and Clark Lake, and the sections of the Missouri River below Fort Peck Dam and Fort Randall Dam.

Recovery goals have been set for each species and actions to prevent jeopardy to their continued existence have been identified in the 2003 Biological Opinion Amendment. The 1990 recovery plan for the interior population of the least tern set state goals, but not specific Missouri River goals, for some of the states (USFWS 1990). In Montana, the goal was set at 50 adults, which would include both the Missouri and Yellowstone Rivers. For North Dakota the goal was set at 250 adults, which essentially is a Missouri River goal as least terns are only rarely found off of the Missouri River in that state. For South Dakota the goal was set at 680 adults with 80 adults on the Cheyenne River, 100 adults on Lake Oahe, 80 adults on the Missouri River below Fort Randall Dam, 20 adults on other Missouri River sites and 400 adults on the Missouri River below Gavins Point Dam, with these adults being shared with the state of Nebraska. The Missouri River goal, essentially, was set at 900 adults.

An adult census has been conducted for least terns on the Missouri River every year since 1986. Limited productivity monitoring was done on various segments of the Missouri from 1986 through 1993. From 1993 through 2001 productivity surveys were done on all segments of the river between Fort Peck Lake and Ponca State Park except for the Fort Peck River Segment, which was sub-sampled and Lake Sharpe, which was not surveyed. Since 2002 complete surveys have been done on all Missouri River Segments between Fort Peck Lake and Ponca State Park except for Lake Sharpe. Adult numbers have ranged from a low of 427 in 1997 to a high of 1,010 in 2007, with an annual average of 658 adults. In the 23 years of adult surveys on the Missouri River, the recovery goal of 900 adults has

been exceeded twice (2005 and 2007).

The 1988 recovery plan for the northern Great Plains population of the piping plover set population goals specific to the Missouri River (USFWS 1988). For Montana, there is no recommendation for pairs; North Dakota, 100 pairs; South Dakota, 325 pairs (including 250 pairs shared with Nebraska); and Nebraska, 250 pairs (shared with South Dakota) (USFWS 1988). The Missouri River goal therefore is 425 pairs. This goal was exceeded in 2001 and every year through 2008.

According to the recovery plans, the decline in the populations of these species can be attributed to the channelization of the river and modification of river flows which resulted in the degradation of sandbar habitat. Historically, least terns and piping plovers were widely distributed throughout the Missouri River system. Dams and water management on the Missouri River have altered the natural hydrograph, and changed the sediment transport system that created dynamic habitats. Prior to the high flows of 1993 and 1997 Houtcooper et al (1985) documented that natural sandbars free of vegetation which provide nesting habitat for terns and plovers had declined in abundance.

More recently much of the habitat created during high flows has eroded away or become too vegetated to be used. According to VanderLee (2002) steady flows between study years (1998-2000) provided little or no vegetation scouring and vegetation increased 3-fold. While there is little quantitative data since the VanderLee study on the amount of habitat lost, it can be assumed that because there has been no substantial spike in flows that would create habitat or provide a scouring effect on sandbars, additional decline in quality and quantity of habitat has occurred. In recent years flows out of the Gavins Point Dam have been lower than normal due to drought conditions in the basin. These low flows have exposed low elevation sandbars which were available and used for nesting. However, as drought conditions improve in the basin, releases will increase out of Gavins Point Dam once again, covering these low elevation sandbars. When fewer quality sandbars are available, nests can be concentrated on fewer sites that are not as widely dispersed as they were historically, possibly increasing the incidence of predation

(Kruse et al. 2001).

The 2003 Biological Opinion Amendment states “Due to the reduction in frequency of flows that are of sufficient magnitude to scour vegetation from existing sandbars and create new sandbar habitats, the Corps’ action will indirectly increase the number of eggs, chicks, and adults that predators kill in the action area.” Since the last high water event on the Missouri River (1997), there has been an increase in least tern and piping plover nest predation (USACE 2008) (Figure 1). To address the decline in habitat abundance the Corps has undertaken efforts to enhance and increase the amount of habitat available on the Missouri River for nesting terns and plovers. The Corps increases the amount of available nesting habitat each year by removing vegetation from existing sandbars and by constructing new sandbars. This habitat attracts high numbers of breeding least terns and piping plovers year after year. The high concentration of nests on newly modified or created sandbars may make them more vulnerable to predation (Sovada et al. 2001). The Corps is working to further increase the number of emergent sandbar habitat (ESH) acres within the Missouri River. Emergent sandbar habitat refers to sandbars with exposed surfaces above the water within the river channel, as opposed to submerged sandbars, which are completely submerged under water. In contrast to islands, ESH complexes are temporary formations and comparatively dynamic in nature. The purpose is to spread out the distribution of suitable ESH so that nests are not so highly concentrated and are not an easy target for predators. To date, most sandbar modification and creation has occurred in the 59-mile segment of the Missouri River below Gavins Point Dam, but future efforts will be undertaken in other segments of the river as well. In the meantime, predation management would aid in sustaining and increasing plover and tern numbers and productivity while habitat is being constructed or modified.

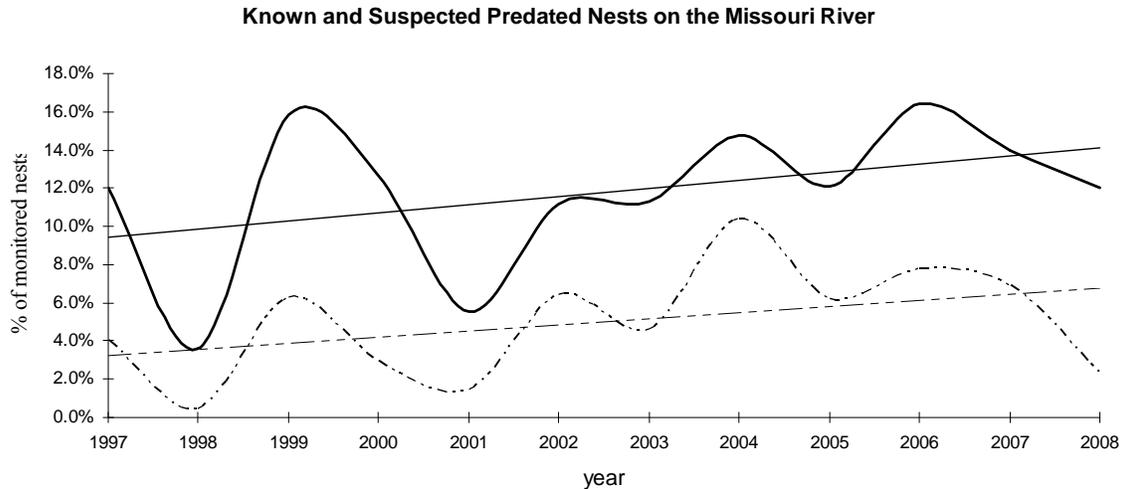


Figure 1. Nests documented as predated (· · — · ·) by TPMP crews versus nests suspected to be predated (—) since high flows in 1997 (USACE 2008).

Fledge ratio goals were set as a metric in the 2003 Biological Opinion Amendment as an indication of population sustainability. Fledged chicks are those that have been seen flying or “jump-flying” and chicks seen alive at least 20 days after hatching and not seen on a subsequent visit at least five days later (USFWS 2003). To determine the fledge ratio, the Corps divides the total number of fledged chicks by the number of nesting pairs (total number of adults counted divided by two) (USFWS 2003). Current Corps data for the Missouri River shows fluctuating fledge ratios over the last 15 years (Figure 2). Tern fledge ratio numbers range from 0.09 in 1996 to 1.63 in 1998. Fledge ratios for piping plovers have also fluctuated, ranging from 0.16 in 1995 to 1.89 in 2002. Fledge ratio goals for both species on the Missouri River (0.94 for least terns and 1.22 for piping plovers) were most recently exceeded in 2004 for plovers and 2005 for terns. However, since then fledge ratios have declined until last year when there was another increase. The magnitude of predation impacts on adults and chicks is difficult to measure because, typically, evidence is lacking or ephemeral. Current monitoring efforts do not assess chick and adult fates. However, there are instances when circumstances lead to a reasonable assumption that predation contributed to low productivity on a site (e.g., sign of predator presence such as tracks, feathers, or feces, timed with reduction in numbers of chicks). Also, the detectability of least tern and piping plover chicks in vegetated habitats

may affect the reported fledge ratios. The detectability of chicks is directly related to amount of vegetative cover; the more vegetation on a site, the more difficult it is to observe chicks (D.H. Catlin, Virginia Polytechnic Institute, unpublished data). Fledge ratios at sites with little or no vegetation may be higher than sites with moderate or heavy vegetation cover.

Although there does not appear to be any studies in the scientific literature that document predation rates for least terns and piping plovers on other river systems, two studies have given predation rates for unprotected nests in other aquatic systems. For example, the clutch predation rate on unprotected piping plover nests in 1992 and 1993 was found to be 19% at Lake Diefenbaker, Saskatchewan, where up to 5% of the world’s population of piping plover breeds (Espie et al. 1998). The predation rate of unprotected least tern nests on a Massachusetts barrier island was 53% from 1987-1989 (Rimmer and Deblinger 1992).

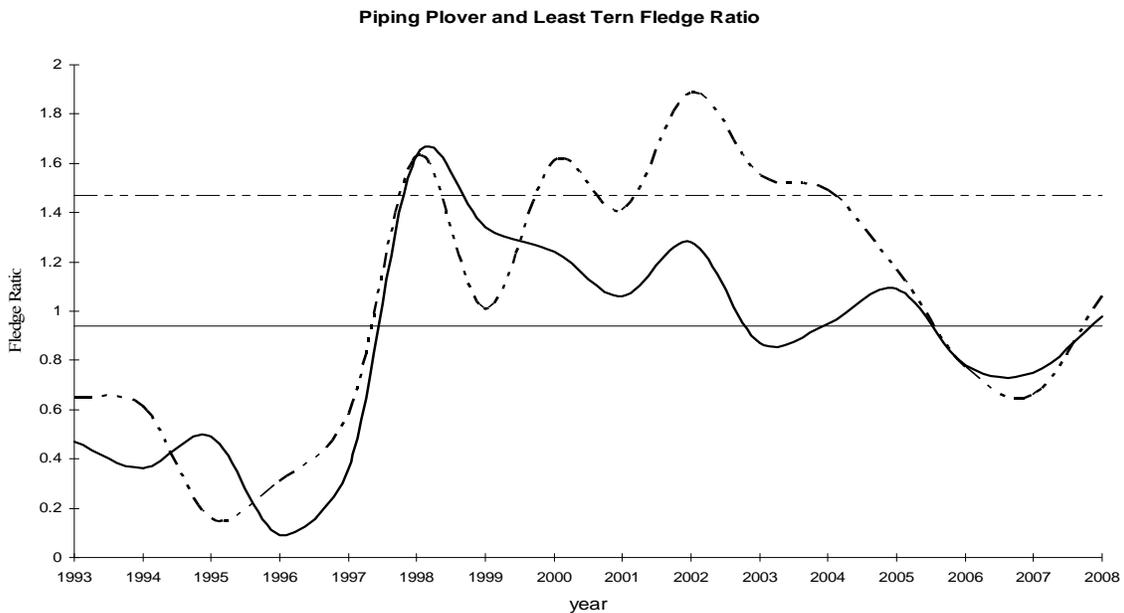


Figure 2. Piping plover (· · — · ·) and least tern (—) fledge ratios compared to goals set in the 2003 Biological Opinion Amendment (USFWS 2003, USACE 2008).

Predation has been identified as a factor that limits the productivity of terns and plovers on the Missouri River (Dirks 1990, Higgins and Brashier 1993, Higgins and Kruse 1999, Mayer and Ryan 1991; USFWS 1991, 1992). Human activities since settlement have influenced distributions and populations of predators. Indirect (e.g., agricultural practices) and direct (e.g., poisoning campaigns, overharvest) influences include: 1) abundance of individual predator species, 2) composition of the predator community, and 3) foraging behavior and movements of predators (e.g., more confined foraging locations) (Sargeant et. al. 1993). Agricultural practices have resulted in landscape-scale alteration of habitats that have been beneficial for some species (e.g., American crow (*Corvus brachyrhynchos*) and raccoon (*Procyon lotor*)). The increase in crow and raccoon numbers has likely been detrimental to nesting plovers and terns (Nichols 1999). Furthermore, declines in river otter (*Lutra canadensis*) through overharvest likely facilitated an increase in the mink population along the Missouri River and tributaries (Kiesow 2003). This change in predator species composition likely was detrimental to nesting terns and plovers (Ferrerias and MacDonald 1999).

Least terns and piping plovers are impacted by a variety of predators. Eggs and chicks are most often targeted by predators, but occasionally adults are depredated. Cryptic coloration is one adaptation for protecting eggs and chicks from detection by predators. Chicks will hide under driftwood and in vegetation. Adults of both species will attempt to defend the nests and chicks against predators; piping plovers use a “broken wing” display to lure predators away and least terns harass (swoop) intruders to repel them from the nesting area.

A variety of bird, mammal, and snake species have been documented preying on or are suspected of preying on least tern and/or piping plover eggs, chicks, and/or adults in the Great Plains and other areas of the United States and Canada (Tables 1, 2, 3). However, of these species, four - the great horned owl, raccoon, mink, and coyote – have had the largest impact on least tern and piping plover productivity on the Missouri River (Kruse et al. 2001, USACE 2008).

Table 1. Species documented as taking least tern and/or piping plover eggs, chicks, and/or adults.

Common name	Scientific name	Reference
Mammals		
Coyote	<i>Canis latrans</i>	Jenniges and Plettner 2008
Domestic dog	<i>Canis familiaris</i>	Kruse et al. 2001
Mink	<i>Mustela vison</i>	Kruse et al. 2001
Raccoon	<i>Procyon lotor</i>	Kruse et al. 2001
Birds		
American crow	<i>Corvus brachyrhynchos</i>	Kruse et al. 2001
American kestrel	<i>Falco sparverius</i>	Kruse et al. 2001
Black-billed magpie	<i>Pica hudsonia</i>	Licht and Johnson 1992
Common raven	<i>Corvus corax</i>	Schmelzeisen et al. 2004
European starling	<i>Sturnus vulgaris</i>	DeVault et al. 2005
Great blue heron	<i>Ardea herodias</i>	Mabee and Estelle 2000
Great horned owl	<i>Bubo virginianus</i>	Kruse et al. 2001
Northern harrier	<i>Circus cyaneus</i>	Ivan and Murphy 2005
Merlin	<i>Falco columbarius</i>	Michaud and Prescott 1999
Peregrine falcon	<i>Falco peregrinus</i>	Goossen et al. 2002
Red-tailed hawk	<i>Buteo jamaicensis</i>	Jenniges and Plettner 2008
Ring-billed gull	<i>Larus delawarensis</i>	DeVault et al. 2005
Reptiles		
Various snake species	Order Squamata	Jenniges and Plettner 2008

Table 2. Species documented as inadvertently taking least tern and/or piping plover eggs, chicks, and/or adults (for example, stepping on eggs).

Common name	Scientific name	Reference
Mammals		
Cattle	Bovidae	Jenniges and Plettner 2008
White-tailed deer	<i>Odocoileus virginianus</i>	Ivan and Murphy 2005
Birds		
Canada goose	<i>Branta canadensis</i>	Jenniges and Plettner 2008

Table 3. Species documented as possibly taking least tern and/or piping plover eggs, chicks, and/or adults.

Common name	Scientific name	Reference
Mammals		
American badger	<i>Taxidea taxus</i>	Ivan and Murphy 2005
Ground squirrels	<i>Spermophilus</i> spp.	Ivan and Murphy 2005
Red fox	<i>Vulpes vulpes</i>	Ivan and Murphy 2005
Striped skunk	<i>Mephitis mephitis</i>	Ivan and Murphy 2005
Short-tailed weasel	<i>Mustela erminea</i>	Haig and Elliott-Smith 2004
Birds		
Blackbirds	Icteridae	Ivan and Murphy 2005
California gull	<i>Larus californicus</i>	Murphy et al. 2003a
Common grackle	<i>Quiscalus quiscula</i>	Ivan and Murphy 2005
Herring gull	<i>Larus argentatus</i>	USFWS 2003
Short-eared owl	<i>Asio flammeus</i>	Goossen et al. 2002
Snowy owl	<i>Bubo scandiacus</i>	Cuthbert and Wemmer 1999
Swainson's hawk	<i>Buteo swainsoni</i>	Murphy et al. 2003a

On the Missouri River, three of the species listed above have had the largest impact on least tern and piping plover productivity. While conducting research in 1991 and 1992, Kruse et al. (2001) documented that raccoon and mink were responsible for most of the known nest predation (77.3%) and great horned owls were responsible for most of the known chick predation (68.2%). Of the depredated nests monitored by the Corps from 1993 through 2007 with a predator identified, raccoon and mink have been implicated 68.4% (214/313) of the time (USACE 2008). These three species, as well as coyotes, which have been the leading cause of nest predation on the shorelines of Lake Oahe (USACE 2008), will be the target species for removal under this plan since they have a greater impact on least tern and piping plover productivity relative to the other predator species listed above. The Corps will actively seek to remove individuals of these four target species that are determined to pose a high risk to a least tern or piping plover colony. These individuals will be trapped and then relocated or euthanized as described later in the section Guidelines for Management Actions. Predators in general, whether they are the four target species or other species listed above that are documented or potential least tern and piping plover predators, will also be discouraged from predating

upon nests with the use of predator exclosures (cages and fencing) and hazing as described in the section Guidelines for Management Actions.

The Corps' ability to measure predation rates and effects on tern and plover nests, chicks, and adults is currently limited. Research is ongoing to evaluate the effectiveness of the Corps monitoring program. Information obtained may allow the Corps to better calculate the amount of predation experienced on the Missouri River. The current Corps productivity monitoring program requires nests be visited every seven to ten days. These infrequent visits make it difficult to detect evidence that would implicate a predator in the failure of a nest. Predation rates can be calculated using the existing data but one should take into consideration the limitations of the program. Of the nests monitored by the Corps in the last ten years (1999-2008) on both natural and constructed sandbars on the Missouri River, predators have been directly identified in the loss of 5.1% (292/5,716) of piping plover nests and 6.7% (336/5,052) of least tern nests. These estimates are conservative because they include only nests that were positively identified as being depredated through evidence left at the nest bowl, such as track trails, feces, and feathers. Nests that fail and are relocated with no eggs and no evidence of such things as weather events or flooding are categorized as "unsuccessful no evidence." The Corps considers all "unsuccessful no evidence" nests to be suspected of depredation. Using TPMP data (1993-2008) we suspect a maximum of 13.4% (1,897/13,918) of all nests are depredated compared to the 6.2% (883/13,918) of nests documented as predated (USACE 2008) (Figure 3, Table 4).

Known and Suspected Predated Nests on the Missouri River

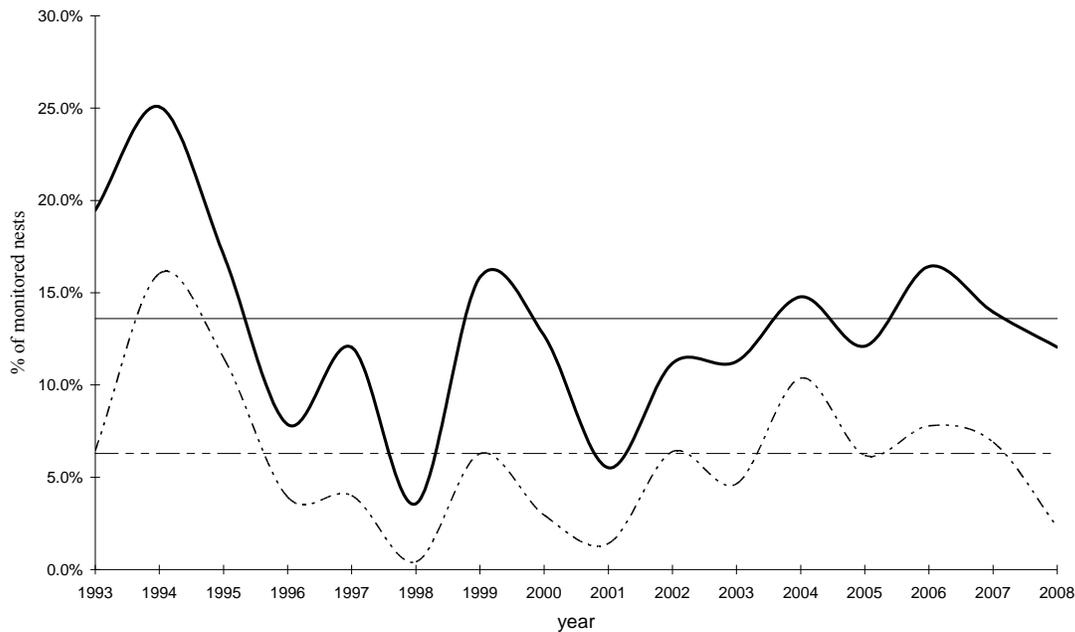


Figure 3. Nests documented as predated (· · — · ·) by TPMP crews versus nests suspected to be predated (—) (USACE 2008).

Monitoring of least tern and piping plover breeding activities on sandbars constructed below Gavins Point Dam (RM 755.0 – completed in 2004, 761.3, and 770.0 - completed in 2005, and 791.5, 777.7 and 775.0 completed in 2008) showed high productivity in the first nesting season after construction (Table 5). The combined first year fledge ratios for the six constructed sandbar complexes were 2.40 for plovers and 1.93 for terns. Combined fledge ratios were calculated by taking all fledglings from only constructed sites and dividing them by the number of adult pairs from those same sites. In subsequent years densities increased and productivity for the three older sandbars dropped substantially with a combined fledge ratio of 0.87 for plovers and 0.50 for terns (755.0 – 2004-2008, 770.0 and 761.3 – 2005-2008). However, apparent nest success for these sandbars remained high for 2004-2008 with 68% of plover nests (248/367) and 70% of tern nests (402/577) hatching out at least one egg (USACE 2008). The reason for the low productivity on these older bars was due to high chick mortality. In the absence of evidence of chick losses due to weather events, the most likely causes of the recorded

high chick mortality were likely predation (as documented in Table 5). These constructed sites have remained fairly vegetation free and detectability is not thought to be an issue when determining the fledge ratios for these constructed sites.

Due to the higher amount of nests on the constructed sandbars compared to the natural sandbars, an individual predator can have a significant impact on the survival of eggs, chicks, and adults on the constructed sandbars. For example, sandbars that were naturally created below Gavins Point Dam in the years following the high water in 1997/1998-2001 averaged 9.7 nests per site while sandbars constructed by the Corps since 2004 have averaged 63 nests per site (USACE 2008). Therefore, although predation rates may be similar between natural and constructed sandbars (Tables 4 and 5), the total number of nests predated tends to be higher on the constructed sandbars because they have a greater number of nests. Predation management focused on constructed sandbars may be more effective than management focused on natural sandbars.

		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Missouri River	# nests monitored	637	686	645	407	299	476	762	678	779	1002	1056	1204	1388	1309	1376	1212	13916
	known # nests predated	41	110	74	16	12	2	48	20	11	64	49	125	86	89	86	28	861
	suspected # nests predated	124	172	110	32	36	17	121	86	43	112	119	178	168	215	192	146	1871
	known % nests predated	6.4%	16.0%	11.5%	3.9%	4.0%	0.4%	6.3%	2.9%	1.4%	6.4%	4.6%	10.4%	6.2%	7.8%	6.3%	2.3%	6.2%
	suspected % nests predated	19.5%	25.1%	17.1%	7.9%	12.0%	3.6%	15.8%	12.7%	5.5%	11.2%	11.3%	14.8%	12.1%	17.4%	14.0%	12.0%	13.4%
Lower Missouri River South Dakota / Nebraska Boader	# nests monitored	321	334	227	139	120	246	426	429	325	523	526	535	672	602	617	591	6633
	known # nests predated	20	100	48	6	8	1	38	14	3	57	30	102	71	51	59	18	626
	suspected # nests predated	59	121	49	21	26	6	84	67	25	83	54	138	120	105	86	92	1136
	known % nests predated	6.2%	29.9%	21.1%	4.3%	6.7%	0.4%	8.9%	3.3%	0.9%	10.9%	5.8%	19.1%	10.6%	9.1%	9.6%	3.0%	9.4%
	suspected % nests predated	18.4%	36.2%	21.6%	15.1%	21.7%	2.4%	19.7%	15.6%	7.7%	15.9%	10.4%	25.8%	17.9%	18.1%	13.9%	15.6%	17.1%
Upper Missouri River Montana North Dakota South Dakota	# nests monitored	316	352	418	268	179	230	336	249	454	479	530	669	716	707	759	621	7283
	known # nests predated	21	10	26	10	4	1	10	6	8	7	19	23	15	38	27	10	235
	suspected # nests predated	65	51	61	11	10	11	37	19	18	29	65	40	48	110	106	54	735
	known % nests predated	6.6%	2.8%	6.2%	3.7%	2.2%	0.4%	6.0%	2.4%	1.8%	1.5%	3.6%	3.4%	1.9%	6.5%	3.6%	1.6%	3.2%
	suspected % nests predated	20.6%	14.5%	14.6%	4.1%	5.6%	4.8%	14.0%	7.6%	4.0%	6.1%	12.3%	6.0%	6.0%	16.7%	14.0%	8.7%	10.1%

Table 4. Nests documented by the Corps as predated and nests suspected to be predated on the entire Missouri River compared to the lower and upper portions of the river (USACE 2008). Because the first constructed sandbar was created in 2004, the years 2004-2008 include data for natural and constructed sandbars combined. The years 1993-2003 include data only for natural sandbars.

	755					761				770				775	777	791	826	827		Total	
	2004	2005	2006	2007	2008	2005	2006	2007	2008	2005	2006	2007	2008	2008	2008	2008	2008	2007	2008	Year 1	Subs
Least Terns and Piping Plovers																					
# nests monitored	64	55	36	46	25	66	86	69	43	114	188	107	52	29	64	40	82	82	93	541	800
known # nests predated	0	6	1	0	4	1	0	0	1	2	8	5	1	0	6	0	0	1	1	10	27
suspected # nests predated	0	18	2	0	11	1	2	0	4	2	20	7	19	1	7	1	7	5	20	24	103
known %nests predated	0%	10.9%	2.8%	0%	16.0%	1.5%	0%	0%	2.3%	1.8%	4.3%	4.7%	1.9%	0%	9.4%	0%	0%	1.2%	1.1%	1.8%	3.4%
suspected %nests predated	0%	32.7%	5.6%	0%	44.0%	1.5%	2.3%	0%	9.3%	1.8%	10.6%	6.5%	36.5%	3.4%	10.9%	2.5%	8.5%	6.1%	21.5%	4.4%	12.9%
Piping Plovers																					
# adults observed	18	32	8	11	8	42	68	62	30	60	80	73	43	5	64	24	16	16	32	245	447
suspected # chicks hatched	32	31	15	23	8	70	111	130	73	96	159	124	63	23	79	33	31	44	26	408	763
suspected # chicks fledged	23	6	5	0	8	55	55	20	15	76	30	10	32	19	60	22	31	18	8	304	189
suspected % chicks fledged	71.9%	19.4%	33.3%	0%	100.0%	78.6%	49.5%	15.4%	20.5%	79.2%	18.9%	8.1%	50.8%	82.6%	75.9%	66.7%	100.0%	40.9%	30.8%	74.5%	24.8%
fledge ratio	2.56	0.38	1.25	0.00	2.00	2.62	1.62	0.65	1.00	2.53	0.75	0.27	1.49	7.60	1.88	1.83	3.88	2.25	0.50	2.48	0.85
Least Terns																					
# adults observed	84	68	38	68	32	58	40	48	20	80	176	94	26	31	60	52	110	52	92	527	702
suspected # chicks hatched	113	36	34	91	18	73	51	70	18	129	183	125	29	53	39	75	81	132	60	695	715
suspected # chicks fledged	64	12	8	5	7	67	29	20	7	102	46	10	9	29	26	65	43	56	15	452	168
suspected % chicks fledged	56.6%	33.3%	23.5%	5.5%	38.9%	91.8%	56.9%	28.6%	38.9%	79.1%	25.1%	8.0%	31.0%	54.7%	66.7%	86.7%	53.1%	42.4%	25.0%	65.0%	23.5%
fledge ratio	1.52	0.35	0.42	0.15	0.44	2.31	1.45	0.83	0.70	2.55	0.52	0.21	0.69	1.87	0.87	2.50	0.78	2.15	0.33	1.72	0.48

Table 5. Productivity of least terns and piping plovers on constructed habitats on the Missouri River (USACE 2008). The fledge ratio is calculated by dividing the suspected number of chicks fledged by the number of nesting pairs, which is estimated by dividing the total number of adults observed by two (USFWS 2003).

Review of Previous Predation Management Efforts on the Missouri River

1991: Kruse et al. (2001) evaluated nest enclosure cages to improve success of plover nests and chick escape shelters to improve survival of piping plover and least tern chicks on the Fort Randall and Gavins Point segments of the Missouri River. They reported apparent nest success for piping plovers was significantly improved by caging nests (62% vs. 34%). However, chick shelters were not used by piping plover or least tern chicks. Since 1991, nest enclosure cages have been used every year at piping plover nests on the Missouri River.

1994: Predator removal was conducted at one site on Lake Sakakawea. A red fox was observed on an island in the Van Hook Arm where plovers had established a nest and where terns had been observed along the shoreline. An interagency agreement was developed with the USDA Animal Damage Control in North Dakota and the fox was removed by a wildlife specialist.

Strobe light systems were used to deter nocturnal predators on four sites on the Gavins Point River segment (804.6, 803.8, 802.7, and 799.2) and at one site on Lake Oahe (1270). For the four sites on the Gavins Point Segment least tern nest success was 69% (46/67) and piping plover nest success was 100% (8/8). The least tern success for non strobe light sites on the Gavins Point River Segment was 19% (29/152). On River Mile (RM) 1270 least tern nest success was 21% (11/52) and piping plover nest success was 61% (11/18). The least tern success for non strobe light sites on the Lake Oahe Segment was 16% (3/19). For all Missouri River sites where strobe lights were used, 48% (57/119) of known least tern nests and 73% (19/26) of known piping plover nests hatched.

1995: The Corps obtained permits to trap up to 10 owls from release sites of captive reared least terns and piping plovers. Pole traps were placed at RM 801, 803.8, and 804.6. Five great horned owls were captured and euthanized. During a necropsy of one

owl, USFWS bands and flags used to mark captive reared terns and plovers were found in its stomach.

1997: Three live traps were placed on the Southport tern colony (RM 1312.7) after mammalian tracks were observed by the Corps crew. This was one of only two tern nesting sites on the Garrison River Reach due to high flows out of Garrison Dam. No predators were caught in the traps.

Two pole traps were installed on Dredge Island (RM 1270) on July 7th to capture great horned owls. Over a one month period, five great horned owls were caught and turned over to the Service. During a survey conducted on July 24, tern feathers (fledgling) were found scattered across Dredge Island suggesting avian predation continued despite the capture of five owls.

1997-1999: Predator exclusion fence was placed on the Steinke Bay habitat project on Lake Sakakawea. Of the six nests at this site; 1 was successful, 1 was collected, 3 were unsuccessful, and 1 had an undetermined fate.

2005: Box type live traps for mammalian predators were placed by the Corps crew at river mile 851.7 on the Fort Randall River segment and river mile 841.7 on Lewis and Clark Lake. Both sites were sandbar complexes that had significant nest loss with evidence suggesting that raccoons were responsible. Traps were set after most nests had already been destroyed. To avoid attracting predators to the nest colonies, the traps were placed on sandbars adjacent to the sandbars containing the remaining nests. No predators were captured although several traps were disturbed (i.e., triggered, dug under).

2007: In response to losses of tern and plover chicks that were attributed to a great horned owl, the Corps contracted with the U.S. Department of Agriculture /APHIS/ Wildlife Services (USDA) to remove owls at four constructed sandbars on the Gavins Point River Segment of the Missouri River and at one constructed sandbar on Lewis and Clark Lake. Live traps were also set on three sandbars on the Gavins Point River

Segment that were being used as control sites for a least tern foraging study being conducted by the U.S. Geological Survey (USGS). On each of the eight sandbars, one modified pole trap and one modified goshawk trap were set from 28 June through 29 June and from 9 July through 10 July 2007. Traps were set on high parts of the sandbars and away from known least tern and piping plover nests. The traps were checked daily. One adult great horned owl was captured in 64 trapping nights (8 modified pole traps x 4 nights + 8 goshawk traps x 4 nights). The owl was captured in the modified pole trap on June 29 on the sandbar at the RM 770 complex. The owl was transported approximately 203 km to the Pawnee State Recreation Area near Lincoln, Nebraska where it was banded and released.

2008: USDA personnel erected seven modified pole traps on the sandbar complex at River Mile 826.5 on Lewis and Clark Lake and two modified pole traps each on the six constructed sandbar complexes at RM 791.5, 777.7, 775.0, 770.0, 761.3 and 755.0 on the Gavins Point River Segment. For four weeks traps were set on Mondays (July 7, 14, 21 and 28) and were disabled on Fridays (July 11, 18 and 25). The traps were removed on August 1, 2008. Five great horned owls were captured in 304 trap-days (19 traps x 4 days/week x 4 weeks) resulting in a 1.6% capture rate. No owls were trapped on any of the seven traps set at RM 826.5 on Lewis and Clark Lake or at the two traps at RM 791.5. One owl each was trapped at RM 777.7, 775.0, 770.0, 761.3 and 755.0. Plover chicks on these sites had significantly higher survival rates than sandbars where no owls were removed during this year (D.H. Catlin, Virginia Polytechnic Institute, unpublished data). The three older constructed sandbars (RM 770.0, 761.3 and 755.0) saw an increase in productivity over the 2004-2007 time period with a combined fledge ratio of 1.36 for piping plovers and 0.59 for least terns (USACE 2008). One owl was taken to Raptor Recovery of Nebraska and the other four were banded and released in Nebraska State Recreational Areas ranging from approximately 193 to 235 km from where they were captured.

Researchers reported the loss of least tern chicks to mink on the constructed sandbar complex at RM 826.5 on Lewis and Clark Lake. In conjunction with the owl trapping,

USDA personnel set 18 conibear traps at various locations on the sandbar complex. The traps were set on July 8, 2008 and were removed on August 1, 2008. No mink were captured during the trapping period.

Management Plan

Implementation of this predation management plan for the Missouri River is intended to reduce predation on least terns and piping plovers. A range of management actions, including direct (lethal and non-lethal removal) and indirect (e.g., caging, fencing, hazing) methods may be implemented. As such, the plan represents a comprehensive predation management program that will integrate and apply practical methods of prevention and control to reduce damage by predators of least terns and piping plovers, while minimizing the harmful effects of the control measures on humans, other species, and the environment. The activities conducted on the Missouri River will vary depending upon the specific problems that are occurring. A particular predator problem may be addressed through the implementation of activities related to resource management, physical exclusion, wildlife management, or any combination of these.

Management Tools

The following is a list of tools that have been used to manage predation of threatened and endangered avian species on the Missouri River system and other parts of the United States. Those tools that were chosen to be implemented to reduce predation of least terns and piping plovers on the Missouri River are listed in the next section, Guidelines for Management Actions.

Habitat Enhancements

Enhancement of least tern and piping plover habitat is beneficial in reducing predation (Kruse et al. 2001, Liebezeit and George 2002). Habitat projects should reproduce a natural environment that decreases predator foraging effectiveness. “Habitat improvements to reduce predator efficiency should include the creation of large, dynamic

sandbar complexes that change in size, location, and vegetation composition...” (Kruse et al. 2001). Some amount of vegetation cover is necessary to allow chicks to escape from predators. Artificial structures have been placed at sites that contain no chick escape cover but the effectiveness of these structures is not well known. On the Missouri River Kruse et al. (2001) documented the use of only one chick shelter by least terns and piping plovers. There is evidence that some predators may focus their foraging at chick shelters (Liebezeit and George 2002).

Through the ESH Program, the Corps seeks to produce least tern and piping plover habitat through the modification of existing sandbars and the construction of new sandbars. Habitat modification projects include the removal of encroaching vegetation on sandbars through herbicide spraying, mowing of vegetation and the overtopping of vegetation with fill material. Habitat modification projects have been done on Lake Oahe, Lewis and Clark Lake, and on the Missouri River below Fort Randall and Gavins Point Dams. Habitat construction projects include the dredging and mechanical placement of fill material to create new sandbars. As of 2009, eight sandbar complexes have been constructed on the Missouri River below Gavins Point Dam and two sandbar complexes has been constructed on Lewis and Clark Lake.

Exclusion Cages

Predator exclusion cages (cages) have been used on piping plover nests on the Missouri River since 1991. Of 6,762 plover nests monitored on the river between 1995 and 2008, 2,459 (36.4%) of those nests were caged. Of the 2,459 caged nests, 1,706 (69.4%) hatched. Of the 4,303 plover nests not caged 2,452 (57.0%) hatched (USACE 2008). During 1991 and 1992, Kruse et al. (2001) documented 62% success for piping plover nests that were caged versus 34% successful non-caged plover nests. The mean piping plover nest success on alkali lakes in North Dakota and Montana has been shown to be higher for caged nests (84%) than for non-caged nests (45%) (Murphy et al. 2003b). Cages are an important tool in increasing plover nest success but do not protect plover chicks after they leave the nest bowl area.

Caging piping plover nests greatly improves nesting success, however studies have shown that predation of adult plovers can occur just outside the cage. Murphy et al. (2003b) reported that out of 1,355 caged plover nests, 73 adult piping plovers were known to be depredated at 68 nests. No adult predation was observed at the 420 non-caged plover nests. Corps data from 1995-2008 shows that there is also a higher abandonment rate for nests that have been caged – 3.9% (96/2,459) compared to non-caged nests – 2.9% (126/4,303) (USACE 2008).

Cages used by the Corps are not used on least tern nests because typically terns fly directly on or off their nests when arriving or leaving. Placement of the current style of cages on tern nests could result in injuries to the adult terns from collision with the wire cage. Restricting the terns' ability to fly directly on or off the nest could also lead to the parents abandoning the nest.

Exclusion Fencing

Electrified fencing has been used as a wildlife management technique since at least the mid-thirties (McAtee 1939). Predator exclusion fence has shown to have high success rates for nesting terns and plovers. Rimmer and Deblinger (1992) successfully used non-electrified fence to protect least tern colonies in Massachusetts. Murphy et al. (2003a) found that when using both fences and cages on alkali wetlands the nest success of piping plovers averaged 98%. Fences have limited deployment for they are best used on narrow peninsulas or point beaches of reservoirs and lakes. Fences do not prevent avian predators from accessing nesting sites and can be used as a perch (Schmelzeisen et al. 2004).

Hazing

Hazing is the use of deterrents or repellents to frighten unwanted species out of an area. Most commonly used hazing types include visual and audio repellants. Examples of some visual repellants include: strobe light systems, lasers, reflective devices, and effigies. Strobe light system and lasers are most effective at night or during low light conditions (Schmelzeisen et al. 2004). Strobe light systems that remain operational throughout the nesting season enhance chick survival (Kruse 1993). Reflective devices, such as Mylar tape, tend to have short term effects as predators adjust quickly to these devices. Effigies

used to deter predators generally resemble humans or other predators (Schmelzeisen et al. 2004). Effigies are most effective when motion is added and they closely resemble the intended figure (Liebezeit and George 2002). Effigies tend to be less effective over time as predator species habituate to their presence (Liebezeit and George 2002).

Examples of some auditory repellants include; ultrasonic emissions, bioacoustics (animal communication signals in the form of alarm or distress calls), pyrotechnics, and exploding devices. Auditory repellants are effective in dispersing avian species from a distinct area but are just as likely to affect least terns and piping plovers (Schmelzeisen et al. 2004). Pyrotechnics are a combination of audio and visual repellants as they emit both light and sound.

Visual and auditory repellants are limited by several factors, including: 1) unintentional hazing of protected species while attempting to haze predatory species; 2) reduced effectiveness over time as some predatory species become accustomed to particular stimuli and begin to ignore them; 3) difficulties in effectively deploying such repellents in the field; and 4) limited effectiveness of repellents on particular species (Schmelzeisen et al. 2004).

Avian Nest Manipulation

Nests can be manipulated in a variety of ways to deter avian predators. Common ways include nest destruction, shaking of eggs, freezing of eggs, oiling of eggs, and removal of eggs. Actions that leave the eggs in the nest but unviable encourages adults to continue trying to incubate and lessens the chance that they will re-nest (Pochop et al. 1998). Covering of eggs with corn oil is 95 to 100 percent effective in preventing eggs from hatching (USDA 2003). Inactive nest destruction, removal of nests before the breeding season, can reduce recruitment of species like owls and merlins since they use nests constructed by other species (Schmelzeisen et al. 2004).

Conditioned Taste Aversion

Conditioned taste aversion occurs when a subject associates eating an item with adverse symptoms caused by a toxic or poisonous substance. Taste aversion was found to be

successful in deterring crows from eating certain colored eggs when the toxin was hidden and the taste of the egg rather than the toxin was avoided (Nicolaus et al. 1982).

Chemicals such as carbamylcholine chloride are recommended for use as a taste aversion agent as it is water soluble and undetectable at its effective dose (Nicolaus et al. 1989).

Individuals must be exposed to a baited egg before they will avoid depredating tern and plover nests. Problems with conditioned taste aversion have been observed where the conditioned individuals are non territorial and allow non-conditioned individuals into a site (Liebezeit and George 2002). This would best be used at sites where crow or gull nest predation has been documented.

Removal

Removal along with the use of other deterrents can be beneficial in increasing the productivity of least tern and piping plovers (Schmelzeisen et al. 2004). Effects from removal of territorial species are often short lived as other individuals quickly occupy vacant territories (Liebezeit and George 2002). Removal of predators can be accomplished by either live or lethal methods. Live methods include hand-held capture poles, box-type mammal traps, Bal-chatri traps, scent-baited padded leg-hold traps, modified goshawk traps, modified Australian crow traps, and perch-pole padded leg-hold traps. Live trapping provides for management options after the capture of an individual. Options include release, relocation, holding, and euthanasia. Lethal removal methods include shooting, poisoning, use of body-gripping traps, or euthanizing individuals after captured using a live-trap. Shooting can be an effective way to remove one or a few individuals in an area but has not been showed to be cost and time effective when applied over a long period of time (Liebezeit and George 2002).

Guidelines for Management Actions

Without the management of mammalian and avian predation, the population size and nesting success of least terns and piping plovers on the Missouri River may be adversely affected. The Corps believes that the following approach to predation management within the various Missouri River segments will improve the productivity of the two species and meet Biological Opinion obligations for on the Missouri River. The proposed areas for

predation management include emergent sandbars and Corps reservoir shorelines along the lower portion of Fort Peck Lake, the Missouri River below Fort Peck Dam to Lake Sakakawea, Lake Sakakawea, the Missouri River below Garrison Dam, Lake Oahe, Lake Francis Case, the Missouri River below Fort Randall Dam, Lewis and Clark Lake, and the Missouri River below Gavins Point Dam to Ponca State Park in Nebraska. Predation management actions could occur any time during the nesting season, which runs from May 1-August 15, but because predation pressure is greatest in July and August, most actions would occur in those months. These actions constitute the Corps preferred alternative as analyzed in the Environmental Assessment (EA).

Predation management activities on Missouri River least tern and piping plover nesting sites has historically been implemented by USDA and by Corps crews. It is likely that the arrangement with USDA will continue in the future on the lower segments of the river within the project area (Fort Randall Dam to Ponca State Park), provided funds are available. Agreements with state and other agencies will be developed to manage predation on the upper segments of the river (Fort Peck Lake to Fort Randall Dam). Contracts for predator control services will be issued annually and will include detailed descriptions of approved control methods, disposition procedures for captured predators, and species-specific protocols.

Various tools and techniques will be used to implement predation management on the Missouri River least tern and piping plover nesting sites and all such methods will be done in accordance with federal and state regulations. The preferred methods include predator exclosures (cages and fences), hazing, and removal. Avian nest manipulation and conditioned taste aversion are two tools that have been used elsewhere that will not be used in the implementation of this plan. The habits of the species preying upon terns and plovers will be evaluated to determine which management technique is employed.

Predators or evidence of predators observed by the Corps crews during their weekly surveys will be reported to the Corps Threatened and Endangered Species Section on the day the observation is made. Problem predators may be identified through direct

observation of predators in the act of hunting or preying on listed species. The presence of predators in the colony can also be established through the identification of tracks of birds, reptiles, or mammals in the nesting colony, dissection of raptor pellets, observations of preyed-upon individuals, eggs, or other material. In many cases these observations can be used to identify the predator impacting the site.

Exclusion Cages

Cages will be placed over piping plover nests as currently done by the Corps crews. The square predator exclusion cages currently used are relatively small, consisting of a 35 x 35 inch top and sides constructed from 2 x 4 inch galvanized weld-wire mesh fencing. New cage designs that will attempt to prevent avian perching and mammals from digging under them will be tested. If new cages are better at deterring these types of predators, they will replace the cages currently being used. The Corps will investigate the feasibility of using large fence-like cages with open tops to help protect tern colonies.

Exclusion Fencing

Fencing of nesting sites may occur at sites where exclusion fences are practical and/or necessary. Fencing would cover a larger area than the exclusion cages and could consist of electrified or non-electrified fencing. The height of fencing used could vary but would generally be around three feet tall. Part of the fence may be buried to prevent predators from digging underneath the fence. It is up to the discretion of the Corps when and where fencing is used. This management action will most likely be used in conjunction with habitat modifications on reservoir shorelines.

Hazing

Hazing may be used by the Corps to deter predators from entering nesting sites. Site selection and type of equipment used for hazing will be at the discretion of the Corps and can include but is not limited to the use of firearms, pyrotechnics and/or other audio or visual stimuli. The Corps will proceed cautiously in the use of these management actions as to limit adverse affects, if any, on terns and plovers. Agencies that have a management responsibility for the geographical location in which the Corps plans on using audio or

visual stimuli will be contacted to ensure the effort does not interfere with other activities.

Removal

Removal efforts will be implemented for the target species: coyotes, raccoons, mink, and great horned owls. Raccoons, mink, and great horned owls are believed to be the primary predators of least terns and piping plovers on the lower portion of the Missouri River within the project area (Fort Randall Dam to Ponca State Park). Coyotes have been the leading cause of nest predation on the shorelines of Lake Oahe (USACE 2008). When one of these species enters an active site, the entire colony's productivity or even survival can be jeopardized in a short time frame. When and where removal takes place is addressed in the section titled Reach Specific Removal Actions. When using traps there is a risk that non-target individuals may be captured and/or injured. Other mammalian predators unintentionally captured while attempting to remove target species would also be euthanized; for example, although badgers are not a target species, they are a suspected predator of terns and plovers and would be euthanized if caught in a live cage trap intended for raccoons. Non-target wildlife that are not documented or suspected predators of least terns and piping plovers, for example turtles and muskrats, would be released. Traps designed to be most effective at capturing target species and most effective at avoiding and minimizing losses of non-target wildlife will be used. Removal efforts for mammals will occur at the colony site or on the immediate shoreline adjacent to the site if owned by the Corps. For example, on Lewis and Clark Lake traps may be set on the delta shore line adjacent to newly constructed ESH sites to capture mink before they enter the sites. Removal efforts for avian predators will occur only at the colony site.

Trapping efforts may be directed toward individual predators other than target species on a case-by-case basis if a predator is observed at a least tern and/or piping plover nesting site and it is deemed to be a threat by the Corps. These will be special cases and prior approval will be sought from agencies that have a management responsibility for the species and/or geographical location. For example, in 1994 a red fox was observed on an island in the Van Hook Arm of Lake Sakakawea where plovers had established a nest and

where terns had been observed along the shoreline. USDA was contacted and the fox was trapped in a live trap and relocated by a wildlife specialist. In areas having a documented history of predation, removal may be more effective if efforts are made before predation is documented during the current year. In all cases involving removal, the most efficient and humane methods available will be used. While using any type of foot-hold trap, the Corps will follow trap refinement recommendations of the American Veterinary Medical Association (2008).

Removal, except in North Dakota, may include capture and euthanasia of mammalian predators, live-capture and relocation of avian predators, and in some cases the lethal removal of returning relocated avian predators that are immediate threats to endangered and threatened species on or near nesting sites. In North Dakota, all species that are not on the federal threatened and endangered species list (North Dakota does not maintain a separate state threatened and endangered species list), mammalian and avian, that are captured will be euthanized because the North Dakota Game and Fish Department does not approve of the relocation of any animal within the state. Lethal removal methods would include shooting coyotes or relocated avian predators that returned to the colony site; killing mink with quick-kill conibear traps; live trapping raccoons caught in cage traps or leg hold traps and then euthanizing them; and euthanizing coyotes caught in leg hold traps. Pole traps are non-lethal traps set for avian predators and may be left out overnight if nocturnal predation is considered a threat to protected species. The use and monitoring of pole traps would be conducted in accordance with USFWS policy (USFWS 2005). Only licensed and authorized agencies or individuals will implement lethal control methods. Traps will be inspected in accordance with state fish and game department codes.

The implementation of this predation management plan may result in temporary localized reductions in populations of some mammalian and avian predators along the Missouri River. The lethal removal of some raptors and mammalian predators may occur annually on the river; however the numbers of individuals likely will represent a small portion of their population. A maximum of 20 individual owls, 20 individual mink, 20 individual

raccoons, and 10 individual coyotes would be removed annually along the river. Lethal removal of avian predators will only be implemented after an individual has been removed, returns, and is later recaptured. In most cases, avian predators will be trapped and released into suitable habitat elsewhere, and only those avian predators that are foraging within nesting areas will be removed. More details about removal methods for the four target predator species are presented below.

Coyote

Options for controlling coyotes at tern and plover colonies would include shooting and trapping. Several methods for trapping coyotes are described in Prevention and Control of Wildlife Damage (Green et al. 1994). The Corps would use a number 1.5 or number 2 leg hold trap to capture coyotes and then euthanize captured coyotes. On reservoir shorelines where the chances of capturing non-target animals such as dogs is greater, the trap would be modified with a padded jaw to minimize damage to the legs of non-target animals (USDA 2009).

Non-lethal management techniques have been studied extensively with coyotes. Some studies have shown that light is more effective in deterring coyotes than sound (Green et al. 1994, Darrow and Shivik 2009). Habituation by coyotes to frightening devices can be slowed by moving the devices periodically and programming them to vary the temporal pattern of multiple stimuli (Linhart et al. 1992, Green et al. 1994).

Mink

According to the Tern Management Handbook (Kress and Hall 2002), mink often have preferred eating locations where they take eggs and other prey, and a toilet area, and these are ideal locations for positioning mink traps. Lethal quick-kill conibear traps baited with live eel are often effective for capturing mink, and the use of only one or two drops of mink scent will help attract mink to traps (Kress and Hall 2002). In predation control efforts on the Missouri River, dead fish obtained from the Corps or U.S. Geological Survey (USGS) is used as bait (USDA 2009). Conibear traps #110 and #120, which measure 4.5 inches x 4.5 inches, would be used for capturing mink (Oneida Victor 2009, USDA 2009).

Raccoons

Raccoons would be captured with either double door (size 3) or single door (size 1081) Hav-a-Hart traps (Kress and Hall 2002) or a similar sized live box trap from another manufacturer. The live traps for raccoons generally have an opening of roughly 10 inches x 10 inches and are 3.5 feet deep. In predation management efforts on the Missouri River, dry cat or dog food marked with a fish oil scent are used as bait (USDA 2009). Live traps are often preferred for raccoons just in case a non-target animal of similar size, such as opossums, is captured so it can be released (USDA 2009). In some situations, such as when a trap is used on a sandbar and there is no evidence of predators of similar size, a number 1.5 leg hold trap may be the preferred capture method (USDA 2009).

Great Horned Owls

Great horned owls can be captured safely using a sliding padded pole trap because of their tendency to perch prior to making an attack. A 5- to 10-foot pole is placed around the threatened area where they can be seen easily and a padded steel leghold trap is placed on the top of the pole. The jaws must be well padded with surgical tubing or foam rubber and wrapped with electrician's tape. A 12-gauge steel wire is run through the trap chain ring and stapled to the top and bottom of the post. This allows the trap to slide to the ground where the bird can rest (Hygnstrom 1994). The bird can then be transported and released to a new location. The tension on the trap is set at a level so that it will not be triggered if birds lighter than an owl land on the trap. There is no data on how far a great horned owl should be relocated to prevent it from returning to a territory. USDA trappers on the Missouri River have used a protocol of relocating owls at least 60 miles from where they are captured (USDA 2008), but this distance may increase in the future depending on the proportion of owls that are found returning to the capture site. The owls are banded before being released. If funding becomes available, the Corps would attach radio transmitters to relocated owls to assess their movements and how often they return to the Missouri River as predators on tern and plover colony sites. If a relocated owl was to return to the colony site it would be euthanized. Euthanized owls would be

disposed of by the responsible trapper or donated to an agency or organization conducting research.

Special Cases

Predator species other than the great horned owl, coyote, mink, and raccoon, may be removed in special cases, when the individual was determined to pose a threat to a piping plover or least tern colony. These special cases are not likely to occur very often and the species removed would most likely be the red fox. For example, from 1991-2008 only one special case was encountered, when a red fox threatened a piping plover colony on an island in Lake Sakakawea and was removed. Other potential predators that could be removed as a special case are other species documented or suspected of preying upon least terns and piping plovers (Tables 1 and 3). A maximum of 3 individuals of any given special case species would be annually removed along the Missouri River, and this is a generous estimate. For mammal species, the appropriate trap would be used depending on the size and behavior of the species (box trap, conibear trap, or leg hold trap) and the mammal would be euthanized. For avian predators, the individual would be relocated and banded except in North Dakota where it would be euthanized. If the bird returned to the colony site, it would be euthanized.

Reach Specific Removal Actions

Nebraska/South Dakota Boundary Waters

This area includes the Missouri River below Fort Randall Dam, Lewis and Clark Lake and the Missouri River below Gavins Point Dam to Ponca State Park in Nebraska. The Corps will establish an agreement/contract with USDA in Nebraska to fund an USDA employee to handle removal efforts for these three segments. These three segments collectively have had the highest percentage of known predated nests (70%, 618/883) on the Missouri River (USACE 2008) (Figure 4) and as of 2008 contain all of the Corps' constructed sandbars. In 2008 great horned owls were captured at two of three first year constructed sandbars. Due to the fact that owls are present at constructed sites the first year, predator removal techniques will be implemented on all constructed sites during the

first three nesting seasons that the sites are available to terns and plovers. After three nesting seasons the same criteria used for natural sites will be used on constructed sites to lessen the chance of unnecessary removal effort. Removal may begin as early as the first piping plover or least tern being observed returning to the segments in the spring. If predators are encountered throughout the nesting season, removal efforts may continue until there are no active nests and active broods at these sites. However, removal efforts are likely to be greatest in July and August when predation pressure is the greatest.

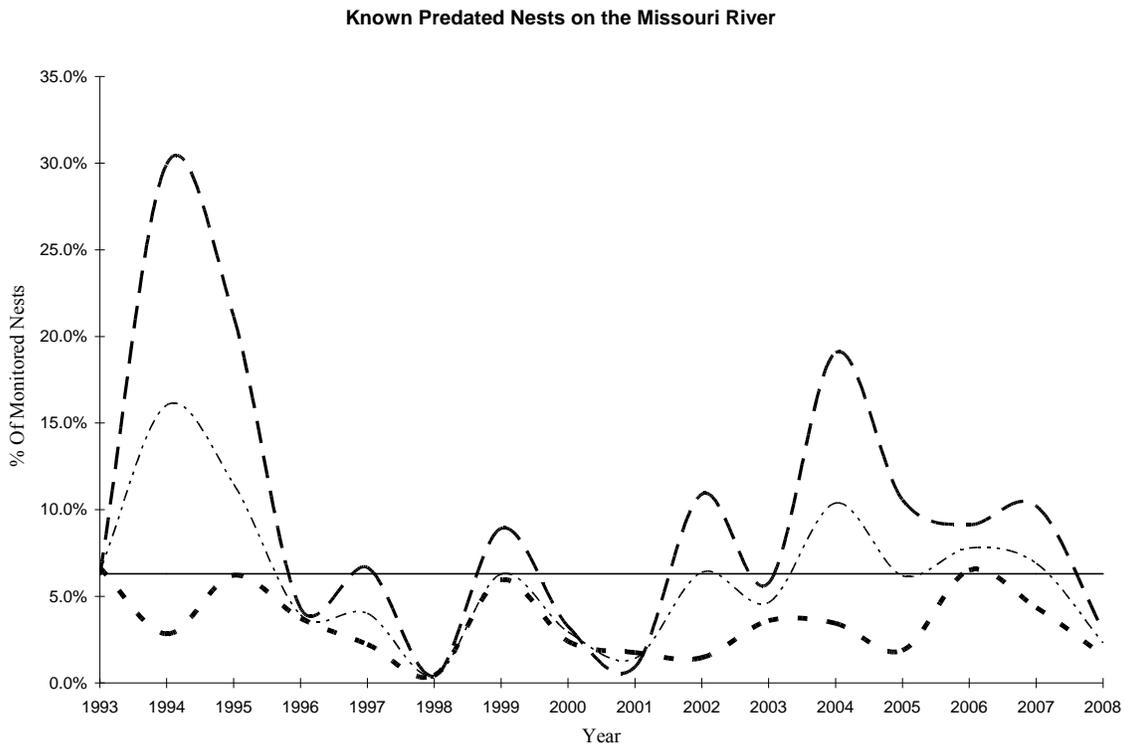


Figure 4. Nests documented as predated by TPMP crews on the entire Missouri River (· · - · ·) compared to the lower (— —) and upper (- - -) portions of the river (USACE 2008).

For non-constructed sites and constructed sites after the third year of nesting availability, when evidence of predation by the target species is reported by the Corps crews the Corps will determine if predation management is necessary. If the Corps judges that measures are necessary to alleviate predation threats, then an appropriate course of action will be implemented. For example, if a raccoon or mink has entered a sandbar the Corps crew will report it to the TPMP program manager. At that time the Corps will determine the risk to terns or plovers at that site (i.e. if there is a high number of adults, chicks and

eggs at the site or a dense population at the site, the predator will be considered to pose a high risk to the colony). If deemed necessary by the Corps, state trappers will be contacted to remove the animal.

South Dakota

This includes Lake Oahe within the State of South Dakota and Lake Francis Case. The South Dakota Interior Least Tern and Piping Plover Management Plan allows the Corps to contract with state trappers on these segments of the river on a case by case basis (Aron 2005). When evidence of predation or predators is reported by the Corps crews the Corps will determine if predation management is necessary. If the Corps judges that measures are necessary to alleviate predation threats then an appropriate course of action will be implemented.

North Dakota

This includes the Missouri River from the Montana border to Lake Sakakawea, Lake Sakakawea, the Missouri River below Garrison Dam and Lake Oahe within the State of North Dakota. The Corps plans to set up an agreement with USDA in North Dakota on these segments for trapping on a case by case basis. When evidence of predation or predators is reported by the Corps crews the Corps will determine if management is necessary. If the Corps judges that measures are necessary to alleviate predation threats then an appropriate course of action will be implemented. To date there are no constructed sites on this segment. If construction takes place on this segment in the future, predation management for constructed sites would mimic that of the Nebraska South Dakota boundary waters.

Montana

This includes the lower portion of Fort Peck Lake and the Missouri River below Fort Peck Dam to the North Dakota Border. The Corps plans to establish an agreement with USDA in Montana on this reach for trapping on a case-by-case basis. When evidence of predation or predators is reported by Corps crews the Corps will determine if management is necessary. If the Corps judges that measures are necessary to alleviate

predation threats then USDA and the Montana Fish, Wildlife and Parks Department will be contacted and the appropriate course of action will be implemented.

Disposal of Captured Animals

All mammalian predators captured will be euthanized in accordance with Wildlife Services Directive 2.430 (USDA 2004). All non-predatory mammals caught unharmed will be released. In the case that a non-target mammal is captured and injured, it will be euthanized. Euthanized mammals will be disposed of by the responsible trapper or donated to an appropriate agency, university or organization conducting research.

All avian predators that are live captured will be removed and relocated back into the wild. Release will be at a location deemed far enough from nesting areas not to allow the species to readily return during the nesting season. Location of all release sites must be approved by the Corps Threatened and Endangered Species Section and the state in which the release will take place. With concern over release locations not being far enough to prevent avian predators from returning, all relocated avian predators during the 2009 and 2010 nesting seasons will be fitted with a metal Service leg band and a colored leg band. If funding is available, the predators will also be fitted with a radio transmitter to track their movements. An avian predator that has been relocated, but returns to tern and plover nesting sites, will be euthanized. Euthanized avian predators will be disposed of by the responsible trapper or donated to an agency or organization conducting research.

All non-target wildlife (species determined not to be a threat to least tern and piping plovers) that is captured unharmed will be immediately released near the capture site. In the event that a captured non-target avian species has sustained substantial injuries and is not a species of concern in the state in which it was captured, it will be euthanized in accordance with Wildlife Services Directive 2.430 (USDA 2004). If the animal has received minor injuries or is a species of concern it will either be released near the capture site or will be taken to an approved rehabilitation/veterinary care facility (i.e. northern

harrier is a species of conservation concern in North Dakota and if that species was captured and injured, attempts would be made to rehabilitate that animal). It will be the Corps' responsibility to maintain current knowledge of both federal and state species of concern and relay such information to those conducting removal efforts in the field.

Monitoring, Reporting and Evaluation

Monitoring of depredation trends will be accomplished by utilizing the Corps crews. The Corps crews visit colony sites every five to ten days during the nesting season and collect productivity and census data. The Corps crews already document any evidence of predation they observe while at these sites (i.e. nest losses, animal tracks, remains of adults and chicks, etc.). By continuing to utilize the Corps crews the amount of research or monitoring disturbance to the birds is not increased. The monitoring of removal efforts will be conducted by the responsible trapper. The trapper will document such things as set times, locations, equipment type, failed attempts, and successful captures. During removal they will provide weekly updates to the Corps. Trappers will also contact the Corps within two hours of any known successful capture of any species.

During the season the Corps will provide a weekly update of activities to those agencies affected by the efforts in a particular segment. The weekly report will consist of all efforts taken to limit predation including enclosure, hazing and removal efforts used along with any evidence of predation documented by the Corps crews. A report will be issued annually describing the actions taken to control predation and the numbers and types of predators influenced. In addition, the report will include documented incidents of predation on least terns and piping plovers along with such things as fledge ratios and hatching rates on sites where management was and was not done. The annual report will include an analysis of the implementation of this plan and serve as the Corps' basis for recommendations. The Corps will make this report available by December 31st of each year or earlier as required by federal and state permits.

Recommendations from analysis of the current year's management actions along with new information gathered on predation will be used to adjust this plan to best suit the needs of least terns and piping plovers on the Missouri River. Evaluation will be conducted in partnership with the agencies affected by these management actions. Adjusting the design and or implementation of this predation management plan, based on an evaluation of current actions and best known data, will allow for effective management in the future.

Cooperators

This plan will be implemented in cooperation with the following agencies and organizations, as appropriate:

- Missouri River Recovery, Integrated Science Program
- USACE, Omaha District Threatened and Endangered Species Section
- US Fish and Wildlife Service
- USDA, Animal Plant Health Inspection Service – Wildlife Services
- NPS, Missouri National Recreation River
- USGS, Northern Prairie Wildlife Research Center
- State of South Dakota Department of Game, Fish and Parks
- State of North Dakota Game and Fish Department
- North Dakota State Water Commission
- State of Montana Fish, Wildlife and Parks
- State of Nebraska Game and Parks Commission
- Virginia Polytechnic Institute, Department of Fisheries and Wildlife Sciences

Alternatives to Consider

Proposed Plan

The proposed predator management plan combines direct actions to control predation along with indirect actions to reduce disturbance and mortality of listed birds. Using a variety of predation management methods in combination would be most effective in

giving the Corps the flexibility to respond to predators and use the appropriate methods for a given situation. The preferred methods include predator exclosures (cages and fences), hazing, lethal removal, and non-lethal removal, as described in the Guidelines for Management Actions section.

Non-lethal Removal Only

Non-lethal removal only would involve implementing only management activities that reduce predation without lethal removal of predators. This would involve trapping and relocating avian or mammal predators. Relocation is defined as the transport and release of a wild animal from one location to another (Fischer and Lindenmayer 2000, ICWDM 2005). Some researchers and wildlife managers use the term translocation instead (Fischer and Lindenmayer 2000, ICWDM 2005) but the term relocation is used throughout this plan. Mammal relocation is not preferred as a management strategy because it is discouraged in the states of North Dakota and Nebraska. Relocated mammals may spread disease into populations at the release site (Cunningham 1996). In addition, relocation efforts for mammals are labor intensive and often fail, with relocated animals often dying after succumbing to predation or failing to adapt to their new locations (Fischer and Lindenmayer 2000). For example, some studies have found high mortality rates, 50% or greater, in relocated raccoons (Teixeira et al. 2007).

Indirect Management Only

Indirect management of predation would involve implementing management activities that reduce predation without removal of predators. Instead, only measures such as the use of visual and auditory repellents and physical barriers would be employed. While hazing with visual and auditory repellents may be effective for a short time frame, animals often become habituated to these devices and are no longer deterred from the area in which these devices are used (Gilsdorf et al. 2002, Schmelzeisen et al. 2004, Cook et al. 2008). Habituation is the process by which animals adjust to and ignore new sights, sounds, and smells over time (Gilsdorf et al. 2002). Physical barriers would be used for some areas along shorelines of reservoirs. However, physical barriers in the absence of the ability to remove a predator are ineffective in controlling avian predation, as well as

some forms of mammalian predation (Schmelzeisen et al. 2004). The use of exclosures over nesting plovers has been effective in protecting eggs, but once the chicks leave the exclosure, they are then vulnerable to predation.

No Additional Predation Management

Under this alternative, no actions would be taken on the river for the specific purpose of managing predation other than the current piping plover nest exclusion protocol used by the Corps. Mammalian and avian predators would not be harassed or specifically deterred from traveling or flying near nesting sites or entering the nesting colonies. The current caging activities conducted by the Corps would not be changed. Previously documented losses of listed species to predation may continue at similar levels, with high predation rates occurring on newly constructed sandbars that attract high densities of terns, plovers, and predators.

Permits

Permits will be acquired as needed and added to this section.

NPS Research Permit – Missouri National Recreational River

USFWS Depredation Permit

State of Nebraska Permit

State of South Dakota Scientific Collectors Permit

State of North Dakota Scientific Collectors Permit

State of Montana Scientific Collectors Permit

North Dakota State Sovereign Lands Permit

Cultural resources are not expected to be present on sandbars but prior to the placement of any predator exclusion fencing or pole traps on Corps reservoir shorelines, the Corps Threatened and Endangered Species Section would notify the Corps project archaeologist and determine if there are any cultural resources present.

References Cited

- American Veterinary Medical Association. 2008. Welfare Implications of Leghold Trap Use in Conservation and Research.
- Aron, C. 2005. South Dakota Interior Least Tern (*Sterna antillarum athalassos*) and Piping Plover (*Charadrius melodus*) Management Plan. South Dakota Department of Game, Fish and Parks, Pierre, Wildlife Division Report No. 2005-02, 76 pp.
- Cook, A., S. Rushton, J. Allan, and A. Baxter. 2008. An evaluation of techniques to control problem bird species on landfill sites. *Environmental Management* 41:834-843.
- Cunningham, A.A. 1996. Disease risks of wildlife relocations. *Conservation Biology* 10(2):349-353.
- Cuthbert, F.J. and L.C. Wemmer. 1999. Recovery of the Great Lakes Piping Plover population: a progress report. Pages 8-17 in K.F. Higgins, M.R. Brashier, and C.D. Kruse (eds.). *Proceedings, Piping Plovers and Least Terns of the Great Plains and Nearby*. South Dakota State University, Brookings, South Dakota.
- Darrow, P.A., and J.A. Shivik. 2009. Bold, shy, and persistent: Variable coyote response to light and sound stimuli. *Applied Animal Behaviour Science* 116(1):82-87.
- DeVault, T.L., M.B. Douglas, J.S. Castrale, C.E. Mills, T. Hayes, and O.E. Rhodes, Jr. 2005. Identification of Nest Predators at a Least Tern Colony in Southwestern Indiana. *Waterbirds*. 28(4): 445-449.
- Dirks, B.J. 1990. Distribution and productivity of Least Terns and Piping Plovers along the Missouri and Cheyenne rivers in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.
- Espie, R.H.M., P.C. James, and R.M. Brigham. 1998. The effects of flooding on piping plover *Charadrius melodus* reproductive success at Lake Diefenbaker, Saskatchewan. *Biological Conservation* 86:215-222.
- Ferreras, P. and D.W. MacDonald. 1999. The Impact of American Mink *Mustela vison* on Water Birds in the Upper Thames. *The Journal of Applied Ecology*, 36(5): 701-708.

- Fischer, J., and D.B. Lindenmayer. 2000. An assessment of the published results of animal relocations. *Biological Conservation* 96(1):1-11.
- Giltsdorf, J.M., S.E. Hygnstrom, and K.C. VerCauteren. 2002. Use of frightening devices in wildlife damage management. *Integrated Pest Management* 7:29-45.
- Goossen, J.P., D.L. Amirault, J. Arndt, R. Bjorge, S. Boates, J. Brazil, S. Brechtel, R. Chiasson, G.N. Corbett, R. Curley, M. Elderkin, S.P. Flemming, W. Harris, L. Heyens, D. Hjertaas, M. Huot, B. Johnson, R. Jones, W. Koonz, P. Laporte, D. McAskill, R.I.G. Morrison, S. Richard, F. Shaffer, C. Stewart, L. Swanson, and E. Wiltse. 2002. National Recovery Plan for Piping Plover (*Charadrius melodus*). National Recovery Plan No. 22. Recovery of Nationally Endangered Wildlife, Ottawa, Ontario. 47 pp.
- Green, J.S., F.R. Henderson, and M.D. Collinge. 1994. Coyotes. P. C-51 to C-76 in: *Prevention and Control of Wildlife Damage*. Hygnstrom, S.E., R.M. Timm, and G.E. Larson, editors. University of Nebraska-Lincoln.
- Haig, S.M. and E. Elliott-Smith. 2004. Piping Plover. In A. Poole (ed.). *The Birds of North America Online*. Cornell Laboratory of Ornithology, Ithaca, New York. Retrieved from The Birds of North America Online database: http://bna.birds.cornell.edu/BNA/account/Piping_Plover/.
- Higgins, K.F. and M.R. Brashier. Editors. 1993. *Proceedings, The Missouri River and its tributaries: Piping Plover and Least Tern symposium*. South Dakota State University, Brookings, South Dakota. 205 pages.
- Higgins, K.F. and C.D. Kruse. Editors. 1999. *Proceedings, Piping Plover and Least Terns of the Great Plains and nearby*. South Dakota State University, Brookings, South Dakota. 132 pages.
- Houtcooper, W.C., D.J. Ode, J.A. Pearson, and G.M. Vandel III. 1985. Rare animals and Plants of South Dakota. *Prairie Naturalist*. 17(3): 143-165.
- Hygnstrom, S.E., and S.R. Craven. 1994. *Hawks and owls. Prevention and control of wildlife damage series*. Cooperative Extension Division, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln; United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control; and Great Plains Agricultural Council, Wildlife Committee.

- ICWDM (Internet Center for Wildlife Damage Management). 2005. Relocating problem wild animals. <http://icwdm.org/wildlife/euthanasia/relocation.asp>
- Ivan, J.S. and R.K. Murphy. 2005. What preys on Piping Plover eggs and chicks? *Wildlife Society Bulletin* 33:113-119.
- Jenniges, J.J. and R.G. Plettner. 2008. Least Tern Nesting at Human Created Habitats in Central Nebraska. *Waterbirds*. 31(2):274-282.
- Kiesow, A.M. 2003. Feasibility of Reintroducing the River Otter (*Lontra Canadensis*) in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.
- Kress, S.W. and C.S. Hall. 2002. Tern Management Handbook: Coastal Northeastern United States and Atlantic Canada. Prepared for the U.S. Fish and Wildlife Service in cooperation with The Canadian Wildlife Service.
- Kruse, C.D. 1993. Influence of predation on least tern and piping plover productivity along the Missouri River in South Dakota. M.S. Thesis, South Dakota State University, Brookings, South Dakota.
- Kruse, C.D., K.F. Higgins, and B.A. Vander Lee. 2001. Influence of predation on piping plover, *Charadrius melodus*, and least tern, *Sterna antillarum*, productivity along the Missouri River in South Dakota. *The Canadian Field Naturalist* 115:480-486.
- Licht, D.S. and K.M. Johnson. 1992. Black-billed Magpie predation on Piping Plover eggs. *Prairie Naturalist* 24: 285.
- Liebezeit, J.R. and T.L. George. 2002. A Summary of Predation by Corvids on Threatened and Endangered Species in California and Management Recommendations to Reduce Corvid Predation. Calif. Dept. Fish and Game, Species Conservation and Recovery Program Rpt. 2002-02, Sacramento, CA. 103pp.
- Linhart, S.B., G.J. Dashch, R.R. Johnson, J.D. Roberts, and C.J. Packham. 1992. Electronic frightening devices for reducing coyote depredation on domestic sheep: efficacy under range conditions and operational use. *Proceedings of the Vertebrate Pest Conference* 15:386-392.
- Mabee, T.J. and V.B. Estelle. 2000. Assessing the Effectiveness of Predator Exclosures for Plovers. *Wilson Bulletin*. 112(1): 14-20.

- Mayer, P.M. and M.R. Ryan. 1991. Electric Fences Reduce Mammalian Predation on Piping Plover Nests and Chicks. *Wildlife Society Bulletin* 19: 59-63.
- McAtee, W.L. 1939. The Electric Fence in Wildlife Management. *The Journal of Wildlife Management*. 3(1): 1-13.
- Michaud, I. and D. Prescott. 1999. Use of predator exclosures to protect piping plover nests in Alberta and Saskatchewan: 1999 field season report. Alberta Conservation Association, Edmonton, AB. 21 pp.
- Murphy, R.K., R.J. Greenwood, J.S. Ivan, and K.A. Smith. 2003a. Predator Exclusion Methods for Managing Endangered Shorebirds: Are Two Barriers Better than One? *Waterbirds* 26(2):156-159.
- Murphy, R.K., I.M.G. Michaud, D.R.C. Prescott, J.S. Ivan, B.J. Anderson, and M.L. French-Pombier. 2003b. Predation on Adult Piping Plovers at Predator Exclusion Cages. *Waterbirds* 26(2):150-155.
- Nichols, R.B. 1999. The Destruction of Wildlife Habitat by Suburban Sprawl and the Mitigating Effects of Land Use Planning. *Proceedings of the 1999 Northeastern Recreation Research Symposium*. Bolton Landing, New York. 177-185.
- Nicolaus, L.K., J.F. Cassel, R.B. Carlson, and C.R. Gustavson. 1982. Taste-Aversion Conditioning of Crows to Predation on Eggs. *Science*. 220: 212-214.
- Nicolaus, L.K., J. Herrera, J.C. Nicolaus, and C.R. Dimmick. 1989. Carbachol as a Conditioned Taste Aversion Agent to Control Avian Depredation. *Agriculture, Ecosystems and Environment*. 26: 13-21.
- Oneida Victor. 2009. Oneida Victor Conibear Traps.
<http://www.oneidavictor.com/conibeartraps.html>
- Pochop, P.A., J.L. Cummings, J.E. Steuber, and C.A. Yoder. 1998. Effectiveness of Several Oils to Reduce Hatchability of Chicken Eggs. *Journal of Wildlife Management*. 62(1): 395-398.
- Rimmer, D.W. and R.D. Deblinger. 1992. Use of Fencing to Limit Terrestrial Predator Movements into Least Tern Colonies. *Colonial Waterbirds*. 15(2): 226-229.
- Sargeant, A.B., R.J. Greenwood, M. Sovada, and T.L. Shaffer. 1993. Distribution and abundance of predators that affect duck production – Prairie Pothole Region. U.S. Fish and Wildlife Service, Resource Publication 194. Bozeman, MT: Mountain

- Prairie Information Node.
<http://bsi.montana.edu/files/bigsky/DistribAbundPredators.pdf> (Version 14MAY06).
- Schmelzeisen, R., D.R.C. Prescott, and L.Engley. 2004. Methods for controlling depredation on Piping Plovers in Alberta: a literature review and synthesis. Alberta Species at Risk Report No. 84. Edmonton, Alberta. 18 pp. plus appendix.
- Sovada, M.A., A.R. Anthony, and B.D.J. Batt. 2001. Predation on Waterfowl in Arctic Tundra and Prairie Breeding Areas. *Wildlife Society Bulletin*. 29(1): 6-15.
- Teixeira, C.P., C. Schetini de Azebedo, M. Mendl, C.F. Cipreste, and R.J. Young. 2007. Revisiting relocation and reintroduction programmes: importance of considering stress. *Animal Behaviour* 73:1-13.
- US Army Corps of Engineers (USACE). 1994. Missouri River Interior Least Tern and Piping Plover Population Status and Productivity Summary.
- US Army Corps of Engineers. 1995. Missouri River Interior Least Tern and Piping Plover Population Status and Productivity Summary.
- US Army Corps of Engineers. 1997. Program Summary: Omaha District – FY 1997 Interior Least Tern and Piping Plover.
- US Army Corps of Engineers. 1998. Biological Opinion Compliance Report: Missouri River Region – FY 1998 Interior Least Tern and Piping Plover.
- US Army Corps of Engineers. 2006. 2005 Annual Report: Biological Opinion on the Operation of the Missouri River Main Stem System, Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.
- US Army Corps of Engineers. 2007. Summary of Predator Control Operations on Lewis and Clark Lake and the Gavins Point River Segment of the Missouri River during the 2007 Least Tern and Piping Plover Nesting Season.
- US Army Corps of Engineers. 2008. Missouri River Recovery Least Tern and Piping Plover Data Management System.
- US Department of Agriculture Animal and Plant Health Inspection Service (USDA). 2003. Egg Oil: An Avian Population Control Tool. Tech Note.
- US Department of Agriculture Animal and Plant Health Inspection Service. 2004. WS

- Directive 2.430; Chemical Immobilization and Euthanizing Agents.
- US Department of Agriculture. 2008. Email communication from Ricky L. Woods, wildlife disease technician, to Kristine Nemec, USACE, December 8, 2008.
- US Department of Agriculture. 2009. Phone conversations with Ricky L. Woods, wildlife disease technician, Kristine Nemec, USACE, January and May 2009.
- US Fish and Wildlife Service (USFWS). 1988. Great Lakes and Northern Great Plains Piping Plover Recovery Plan.
- US Fish and Wildlife Service. 1990. Interior Population of the Least Tern (*Sterna antillarum*) Recovery Plan.
- US Fish and Wildlife Service. 1991. Least Tern and Piping Plover Annual Surveys on the Missouri River. Unpublished Annual Report. 1991. U.S. Fish and Wildlife Service, Ecological Services Office, Pierre, South Dakota.
- US Fish and Wildlife Service. 1992. Least Tern and Piping Plover Annual Surveys on the Missouri River. Unpublished Annual Report. 1992. U.S. Fish and Wildlife Service, Ecological Services Office, Pierre, South Dakota.
- US Fish and Wildlife Service. 2000. Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.
- US Fish and Wildlife Service. 2003. US Fish and Wildlife Service 2003 Amendment to the 2000 Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and Maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System.
- US Fish and Wildlife Service. 2005. Migratory Bird Permit Memorandum: Use of Pole Traps for Capturing Depredating Raptors. MBPM-4.
- VanderLee, B.A., 2002. Completion Report: Evaluation of Least Tern and Piping Plover Habitat on the Missouri River.